

Minimum Maintained Retroreflectivity Guideline Status

By: FHWA Safety Core Business Unit
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Federal, state and local government agencies, working together with academia and the traffic safety services industry, are dedicated to developing and maintaining a safe and efficient transportation system day and night. However, because of reduced visibility at night, this task becomes more challenging. Headlights and roadway lighting help to meet that challenge but are often not enough to fully meet the needs of drivers. This is where the technology of retroreflectivity helps.

Retroreflectivity is the property of a material that returns light to the source. In the case of roadways at night, retroreflective materials may be traffic signs and pavement markings and the source is usually the headlights of a vehicle. Because a driver's eyes are close to a vehicle's headlights, some of the light returned from retroreflective materials reaches the driver's eyes. The amount of light from an object reaching the driver's eyes will have a great impact on how bright that object appears to the driver. Therefore, retroreflective materials that are efficient in returning light to a driver's eyes may appear brighter to the driver than materials that are not as efficient.

This is important because traffic engineers use signs and markings to communicate important information to drivers. At night, if the signs and markings are not illuminated by other means, the retroreflective characteristics are important to increase the chance that a driver receives the information.

There are two basic technologies that make retroreflectivity possible. The first uses very small round glass beads. These tiny glass spheres are applied to white and yellow paints, thermoplastics, epoxies, and other binders to make pavement marking materials retroreflective. Smaller glass spheres are manufactured into sheeting which is then applied to signs and other traffic control devices to make them retroreflective. The second basic technology uses prismatic reflectors consisting of cube-corner elements manufactured into sheeting material that is applied to signs and roadway channelizing devices.

The retroreflective characteristics of traffic control devices gradually deteriorate over time. Because of this, it is important to replace traffic control devices prior to the time when they no longer meet the needs of the nighttime driver.

A major question is not whether the devices should be replaced, but when. How do we know when the device no longer meets the needs of the driver? FHWA is attempting to establish guidance for public agencies to determine the appropriate level of retroreflectivity needed by nighttime drivers.

Background:

80's and 90's: FHWA conducts research to address visibility needs for drivers. Topics such as minimum visibility requirements, implementation strategies, service life, retroreflectometers, were investigated. Tables of research recommended minimum sign retroreflectivity values (after adjustments following the signing workshops in 1995) are included at the end of this briefing (Attachment A).

1992: Congress (1993 Transportation Appropriations Act) - The Secretary of Transportation shall revise the Manual of Uniform Traffic Control Devices to include - (a) a standard for a minimum level of retroreflectivity that must be maintained for pavement markings and signs, which shall apply to all roads open to public travel...

1995: FHWA conducts 3 national signing workshops with state and local agencies to explain research to date

and obtain their advice based on practical experience.

1998: FHWA published two research reports: Impacts on State and Local Agencies for Maintaining Traffic Signs Within Minimum Retroreflectivity Guidelines, Publication No. FHWA-RD-97-053, and An Implementation Guide for Minimum Retroreflectivity Requirements for Traffic Signs, Publication No. FHWA-RD-97-052. Both reports are available through the National Technical Information Service <http://www.ntis.gov/>.

1998: AASHTO requested FHWA to delay rulemaking until a formal AASHTO recommendation can be developed. FHWA agreed. AASHTO's Standing Committee On Highways (SCOH) created a Retroreflectivity Task Force to look at the research and develop recommendations for FHWA. Task force membership includes states, cities, counties, academia, private industry, and FHWA. Chaired by Gary Hoffman, PennDOT.

1999: FHWA conducted 3 national pavement marking workshops with state and local agencies to explain research to date and obtain their advice based on practical experience. Hawkins Engineering prepared the final report on the recommendations from the pavement marking workshops. Copies of the report are available from FHWA (kenneth.opiela@fhwa.dot.gov).

1999: HITEC published evaluations of 6 pavement marking retroreflectometers. <http://www.cerf.org/hitec/eval/complet/retro.htm>

2000: AASHTO's SCOH Retroreflectivity Task Force presented a proposed resolution to SCOH at the annual meeting in December. AASHTO's SCOH and the Board of Directors both approved the resolution (Att. B).

2000: The Millennium edition of the MUTCD (MUTCD 2000) was published. New retroreflectivity levels are not included in the MUTCD 2000. Section 2A.09 is reserved for that purpose. New retroreflectivity guidelines will be added to the MUTCD as an addendum to Section 2A.09 at a later date. The MUTCD 2000 states "Regulatory, warning, and guide signs shall be retroreflective or illuminated to show the same shape and similar color by both day and night, unless specifically stated otherwise in the text discussion in this Manual of a particular sign or group of signs." It also states "Markings that must be visible at night shall be retroreflective unless ambient illumination assures that the markings are adequately visible. All markings on Interstate highways shall be retroreflective." These standards have remained essentially unchanged for 45 years.

2001: HITEC began evaluation of sign retroreflectometers. <http://www.cerf.org/hitec/eval/ongoing/retro.htm>

Current:

Mobile sign retroreflectometers are being demonstrated by the four FHWA Resource Centers. Call the FHWA Division Office in your state to inquire about demonstration schedules.

The FHWA All-Weather Pavement Marking Study final draft report is being revised and should be available soon from FHWA.

There are currently no traceable methods in the United States to determine the accuracy of retroreflectivity measurements because national calibration standards for retroreflectivity do not exist. NCHRP 5-16 has been initiated to develop a dedicated reference instrument to provide national calibration standards for

retroreflectivity, thereby improving the accuracy of measurements made by other instruments.
<http://www4.nationalacademies.org/trb/crp.nsf/All+Projects/NCHRP+5-16>

NCHRP 4-29 (Selection of Materials to Optimize Sign Performance) has been initiated with the objective to develop a simple, user-friendly decision-making tool that will aid transportation agencies in the selection of retroreflective materials for traffic signs, based on roadway conditions and other factors that most critically affect sign performance. The research began in the Spring of 2001 and is expected to last 28 months.
<http://www4.nationalacademies.org/trb/crp.nsf/All+Projects/NCHRP+4-29>

FHWA has funded a sign retroreflectivity value validation analysis by Texas Transportation Institute. This effort will analyze the previous research-recommended values by FHWA and propose changes, if necessary, due to new sign materials, changes in headlights, more advanced analysis tools, and improved knowledge about driver visibility needs. The report from this effort will be delivered to FHWA in the winter of 2001/2002.

FHWA has funded a project by the Texas Transportation Institute to develop and conduct "Train-the-Trainer" workshops for minimum sign and pavement marking retroreflectivity. Three workshops will be held in the winter of 2002/2003. FHWA will be inviting one participant from each Local Technology Assistance Program (LTAP) center in the country to attend one of the workshops. The workshop is expected to be a model that the LTAP centers can use to train local agencies on the same subject.

FHWA plans to draft sign retroreflectivity guideline rulemaking for the Federal Register after reviewing the AASHTO resolution and other input it receives. This rulemaking will only address sign retroreflectivity. Rulemaking on pavement markings will follow at a later date after research is complete and AASHTO has provided a recommendation dealing with pavement markings. FHWA's rulemaking will allow all interested parties to comment on proposed guidelines.

Notes:

The MUTCD is a standard. Therefore, any text in the MUTCD is considered a standard. This means that language for minimum maintained retroreflectivity does not have to be a "shall" condition in the MUTCD to be considered a standard.

Definition of "Standard": "Concept established by authority, custom, or agreement to serve as a model or rule in a measurement of quality or the establishment of a practice or procedure." (ASTM)

Questions or suggestions:

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Attachment A

RESEARCH recommended minimum retroreflectivity values by FHWA:

All values are at 0.2 degree observation angle and –4.0 degree entrance angle

Legend Color: Black Background Color: Yellow or Orange

Legend	Sign Size:	>=48-in	36-in	<=30-in
	Material Type			
Bold Symbol*	ALL	15	20	25
Fine Symbol & Word	I	20	30	35
	II	25	35	45
	III	30	45	55
	IV & VII	40	60	70

All table values in **cd/lx/m2**

* Warning signs with bold symbols:

MUTCD

Code	Sign Type
W1-1	Turn
W1-2	Curve
W1-3	Reverse Turn
W1-4	Reverse Curve
W1-5	Winding Road
W1-6	Large Arrow
W1-7	Double Head Arrow
W1-8	Chevron
W2-1	Cross Road
W2-2	Side Road
W2-4	T Intersection
W2-5	Y Intersection
W20-7a	Flagger Ahead

MUTCD

Code	Sign Type
W3-1a	Stop Ahead
W3-2a	Yield Ahead
W3-3	Signal Ahead
W4-1	Merge
W4-2	Lane Reduction
W 4-3	Added Lane
W6-1	Divided Highway Begins
W6-2	Divided Highway Ends
W6-3	Two-Way Traffic
W8-S	Slippery When Wet
W 11-2	Advance Pedestrian Crossing
W 11A-2	Pedestrian Crossing

Legend Color: Black and/or Black and Red**Background Color: White**

Traffic Speed:	45 mi/h or greater			40 mi/h or less		
Sign Size:	>=48	30-36-in	<=24-in	>=48-in	30-36-in	<=24-in
I	25	35	45	20	25	30
II	30	45	55	25	30	35
III	40	55	70	30	40	45
IV & VII	50	70	90	40	50	60
All table values in cd/lx/m2						

Legend Color: White**Background Color: Red**

Traffic Speed:	45 mi/h or greater						40 mi/h or less					
Sign Size:	>=48-in		36-in		<=30-in		>=48-in		36-in		<=30-in	
Color:	W	R	W	R	W	R	W	R	W	R	W	R
All Signs:	35	8	45	8	50	8	25	5	30	5	35	5
All table values in cd/lx/m2												
Note: Since both the legend and the background of these signs is retroreflectorized a minimum maintained contrast ratio of 4:1 has also been established. If the retroreflectivity value for either the white or red material falls below the value specified in the table or if the retroreflectivity of the white material divided by the retroreflectivity of the red material is less than four, the sign should be replaced.												

Legend Color: White**Background Color: Green**

Traffic Speed:	45 mi/h or greater		40 mi/h or less	
Color:	White	Green	White	Green
Ground-Mounted	35	7	25	5
All table values in cd/lx/m2				

Attachment B

AASHTO Retroreflectivity Policy Resolution approved 12/9/00:

POLICY RESOLUTION

TITLE: MINIMUM LEVELS OF RETROREFLECTIVITY FOR SIGNS

WHEREAS, the American Association of State Highway and Transportation Officials (AASHTO) is aware of the congressional mandate for the Secretary of Transportation to revise the Manual on Uniform Traffic Control Devices to include a standard for the minimum level of retroreflectivity that must be maintained for pavement markings and signs, which shall apply to all roads open to public travel, and

WHEREAS, AASHTO concurs that it is desirable to maintain an adequate level of retroreflectivity for both traffic signs and pavement markings to enhance safety for motorists during hours of darkness and during adverse weather conditions, and

WHEREAS, AASHTO is concerned about additional liability for transportation agencies if the Federal Highway Administration (FHWA) establishes the proposed minimum levels of retroreflectivity, and

WHEREAS, AASHTO greatly appreciates the opportunity afforded by FHWA to consider recommendations from AASHTO prior to publishing proposed rulemaking for minimum retroreflectivity for both signs and pavement markings, and

WHEREAS, AASHTO established a "Task Force on Retroreflectivity Guidelines" composed of members from federal, state and local transportation agencies, and from several transportation and industry associations; and the Task Force has studied the various issues related to FHWA's suggested guidelines for sign retroreflectivity, and has provided interim findings and recommendations;

THEREFORE, BE IT RESOLVED that based upon the findings and recommendations of the Task Force, AASHTO agrees that:

- It is desirable to assure adequate night visibility of traffic signs.
- Regular assessments of the adequacy of retroreflectivity or the planned replacements of signs to assure adequate night visibility is necessary.

BE IT FURTHER RESOLVED, that efforts to assure adequate night visibility should not impose undue burdens on highway agencies, and to that end, AASHTO recommends that FHWA consider the following relative to the retroreflectivity of traffic signs:

1. The minimum requirements need to be presented in a simple and unambiguous format to assure that they can be easily and properly applied.
2. Tables defining minimum retroreflectivity requirements should not appear in the MUTCD to help protect agencies from unnecessary tort liability and to simplify future changes to this evolving process of evaluating sign retroreflectivity.

3. Alternative methods to assess night visibility need to be fully developed.
4. Agencies should have the option to select from the four proposed methods or combination of these methods best suited to their needs and resources.
5. Agencies should have a 6-year period to implement the methods.

FURTHER, it should be noted that the AASHTO Task Force on Retroreflectivity Guides will evaluate forthcoming FHWA findings and recommendations relative to minimum retroreflectivity values for additional types of signs and for pavement markings as they become available, and will provide comments at that time.

FHWA editorial note:

The four methods in No. 4 in the resolution are for evaluation processes and are briefly described as follows:

1. *Measure sign retroreflectivity with instruments and compare to numeric values in tables*
2. *Conduct nighttime sign inspections and compare sign legibility distances to distance values in a table*
3. *Conduct nighttime sign inspections by trained observers that would know how to subjectively evaluate signs*
4. *Knowing how long certain retroreflective materials last in a certain geographic area, replace signs on a schedule to insure replacement prior to the sign reaching the end of its service life*